

REMARKS/ARGUMENTS

This amendment responds to the Office Action mailed on May 5, 2004. In the Office Action the Examiner:

- rejected claims 1, 2, 21, 29, 33, 37, 39, and 42 under 35 U.S.C. § 103(a) as being unpatentable over de Bryun Ouboter et al., 1997, Physica B 239, 203 (hereinafter “de Bryun Ouboter”) in view of Makhlin *et al.*, 2000, IEEE International Symposium on Circuits and Systems, May 28-31, Geneva Switzerland (hereinafter “Makhlin”);
- rejected claims 3-5, and 41 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of United States Patent No. 5,153,171 to Smith *et al.* (hereinafter “Smith”);
- rejected claims 6, 26, 31, and 40 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Ivanov and Claeson, 1987, IEEE Trans. on Magnetics 23, pp. 711-713 (hereinafter “Ivanov”);
- rejected claims 14-19, 45 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Ryazanov *et al.*, February 26, 2001, arXiv:cond-mat/0008364 (hereinafter “Ryazanov”);
- rejected claims 46 and 47 as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Jonker and Han, Proceedings Fifth IEEE International Workshop on Computer Architectures for Machine Perception, Padova Italy, pp. 69-78, September 2000 (hereinafter “Han”);
- rejected claims 48-51, and 59-64 as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Han and further in view of either Smith (claims 48-50), Ivanov (claim 51) or Ryazanov (claims 59-64);
- rejected claims 80-83 and 86 as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Blais and Zagoskin, 2000, Physical Review A 61, 042308-1 - 042308-4 (hereinafter “Blais”) - claims 82, 83, and 86 are rejected in view of this combination of references and further in view of Smith, Ivanov, and Ryazanov, respectively; and

- objected to claims 7–12, 20¹, 22–25, 27–28, 30, 32, 34–36, 38, 43–44, 52–58, 65–79, 84–85, and 87–93 as being dependent upon base claims that have been rejected.

With this amendment, claims 1–3, 5–11, 13, 14, 16–24, 27–38, 46–93 have been amended for clarity. In particular, independent claims 1, 39, 46 and 80 have been amended to indicate the presence of a phase shifter in a superconducting loop. Accordingly, after entry of this amendment, the pending claims remain claims 1–93. Furthermore, the specification has been amended in a number of places to correct typographical errors as will be described in further detail below. No new matter has been added by virtue of these claim amendments and the amendments to the specification.

POWER OF ATTORNEY AND ASSIGNMENT

With this response, Applicants submit a courtesy copy of an assignment from the inventors to assignee D-Wave Systems, Inc. that has been submitted for recordation on even date herewith. Furthermore, Applicants submit a power of attorney revoking all previous attorneys and nominating Jones Day to represent Applicants.

AMENDMENTS TO THE SPECIFICATION AND FORMAL DRAWINGS

Applicants have made a number of amendments to the specification in order to correct typographical errors. In addition, in order to avoid confusion, Applicants have amended the Appendix beginning on page 56 of the specification so that the figures referenced in this section have unique figure numbers. Accordingly, the figures in the Appendix have been renumbered as follows:

Old Figure number in Appendix	New Figure Number
1	14

¹ Statements on page 1 and page 12 of the May 5, 2004 Office Action contradict each other. On page 12, the Examiner objects to claim 20. However, on page 1 claim 20 is listed as rejected. As there is no explicit rejection of claim 20 in the Office Action, Applicants assume that the Examiner intended to object to claim 20 rather than reject the claim. Clarification of this matter is requested in the next communication by the patent office.

Old Figure number in Appendix	New Figure Number
2	15
3	16
4	17

Furthermore, the figures in the Appendix beginning on page 56 have been deleted by amendment to the specification and submitted with this response as proposed formal drawings (Fig. Nos. 14 through 17). Also, figure legends found in the Appendix have been moved to the "Brief Description of the Figures" Section beginning on page 9 of the specification.

CLAIM REJECTIONS UNDER 35 U.S.C. § 103(a)

Claims 1, 2, 21, 29, 33, 37, 39, and 42. The Examiner has rejected claims 1, 2, 21, 29, 37, 39, and 42 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin. Applicants respectfully traverse the rejection for the reasons discussed below.

Applicants note that there are two possible ways to combine the Makhlin and de Bruyn Ouboter devices. In the first possible combination, the Makhlin rf-SQUID is combined with the 4-terminal SQUID of de Bruyn Ouboter such that the Makhlin Josephson junction is integral to the 4-terminal junction of de Bruyn Ouboter. In such a combination, the Makhlin Josephson junction actually separates one or more leads in the 4-terminal junction of de Bruyn Ouboter. When combined in this fashion, the combination device does not teach or suggest the qubit recited in claims 1 and 39, as amended. Claims 1 and 39, as amended, recite that a portion of the phase shift is provided by a phase shifter that interrupts the superconducting loop at a point (i) outside of the multi-terminal Josephson junction (claim 1) or (ii) other than the coupling of two of the plurality of terminals (claim 39). In the first possible combination of the Makhlin and de Bruyn Ouboter SQUIDS, there is no device outside of the 4-terminal junction and interrupting the loop that qualifies as a phase shifter.

In the second possible combination, the Makhlin rf-SQUID is combined with the 4-terminal junction of de Bruyn Ouboter such that the Makhlin Josephson junction

is not integral to the 4-terminal junction of de Bruyn Ouboter. Rather, the Makhlin Josephson junction interrupts the de Bruyn Ouboter superconducting loop at a point outside of the 4-terminal junction. When combined in this fashion, the combination device still does not teach or suggest the qubit of claims 1 and 39, as amended. Claims 1 and 39, as amended, indicate that a portion of the phase shift is provided by a phase shifter that interrupts the superconducting loop at a point (i) outside of the multi-terminal Josephson junction (claim 1) or (ii) other than the point of the coupling of two of the plurality of terminals (claim 39). In the second possible combination of the Makhlin and de Bruyn Ouboter SQUIDS, the only element outside of the 4-terminal junction that can be even considered to affect phase is the Makhlin Josephson junction. But, as will be discussed in detail below, the Makhlin Josephson junction is not a phase shifter. Therefore, the second possible combination of Makhlin and de Bruyn Ouboter does not teach or suggest claims 1 or 39, as amended.

A phase shifter, also termed an "intrinsic phase shifter," is well defined in the specification. For example, as noted on page 16, lines 16-21, of the specification:

A phase shifter is any structure that shifts the phase of the superconducting order parameter Ψ by $\alpha\pi$ in transition through the structure, where α is a constant such that $-1 \leq \alpha \leq 1$. The phase shift in the superconducting loop causes time-reversal symmetry breakdown in the qubit quantum system and thus causes a double degeneracy of the ground state without requiring an external magnetic flux or other influence.

Page 7, lines 16-23, gives specific examples of superconducting loops with phase shifters:

The superconducting loop includes a phase shifter, which may consist of a S-N-D-N-S (for example, niobium / gold / Y Ba₂CU₃O_{7-x} / gold / niobium) junction. If the incoming current is parallel to the a (or b) crystallographic direction of the d-wave material, and the outgoing current is parallel to the b (or a) crystallographic direction of the d-wave material, this S-N-D-N-S junction can give a phase shift of π . Choosing the incoming and outgoing currents to be at any arbitrary angle to each other in the a-b plane in this embodiment allows a more general phase shift.

Furthermore, many examples of phase shifters are illustrated in the specification. For example, Fig. 2A shows an embodiment of a two terminal phase shifter having an SIN/D/N/S heterostructure. The phase shifter of Fig. 2A includes an s-wave superconducting terminal 210 coupled to a normal metal connector which is coupled

to a d-wave superconductor which, in turn, is coupled to a normal metal connector which is coupled to an s-wave superconducting terminal. Figs 2B, 2C, 2D, 2E, 2F, and 2G show additional examples of phase shifters. Common to all of these phase shifters is the property that they cause time-reversal symmetry breakdown in the qubit quantum system and thus cause a double degeneracy of the ground state without requiring an external magnetic flux or other influence.

To be sure, as is true of all Josephson junctions, there is a phase difference across the Makhlin Josephson junction. In fact, Makhlin states that the phase difference across the Makhlin Josephson junction is given by the expression $2\pi\Phi/\Phi_0$ in terms of the flux Φ in the loop. See Makhlin, page II-243, first column. However, this phase difference across the Makhlin Josephson junction does not mean that the Makhlin Josephson junction is a phase shifter. As noted above, the specification states that a phase shifter in a superconducting loop causes *time-reversal symmetry breakdown* in the qubit quantum system and thus causes a double degeneracy of the ground state *without requiring an external magnetic flux or other influence*. The Makhlin Josephson junction does not cause time-reversal symmetry breakdown. Nor does the Makhlin Josephson cause a double degeneracy of the ground state without requiring an external magnetic flux or other influence.

Stated another way, the Makhlin Josephson junction does not impart a phase shift because it is simply a Josephson junction consisting of an insulating gap. The Makhlin Josephson junction cited by the Examiner (Fig. 2a of Makhlin) has an energy profile of:

$$-E_J \cos(2\pi\varphi).$$

See Makhlin, eqn. 4, where $\varphi = 2\pi\Phi/\Phi_0$. Therefore, the energy of the Makhlin Josephson junction is at a minimum when the dynamic phase φ is zero. If the Josephson junction were a phase shifter, it would have a static and intrinsic phase shift that moves the energy minimum of the device away from $\varphi = 0$. In other words, the energy profile of a phase shifter is:

$$-E_J \cos(2\pi\varphi - \varphi_0),$$

where φ_0 is some value other than 0 and represents the static and intrinsic phase shift.

Thus, based on the forgoing reasoning and in view of the amendments to claim 1, Applicants believe that claims 1 and 39 are fully patentable over Makhlin and de

Bruyn Ouboter either alone or in combination. Claims 2, 21, 29, 33, 37, and 42 ultimately depend from either claim 1 or 39 and are therefore patentable over the combination of Makhlin and de Bruyn Ouboter for at least the same reasons that claims 1 and 39 are patentable over this combination of references. Therefore, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 1, 2, 21, 29, 37, 39, and 42 be withdrawn.

Claims 3-5, and 41. The Examiner has rejected claims 3-5, and 41 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Smith. Applicants traverse the rejection.

First, the combination of de Bruyn Ouboter, Makhlin, and Smith does not support a *prima facie* case of obviousness because there is no motivation to combine Smith with either de Bruyn Ouboter or Makhlin. Smith does not disclose the use of SQUIDs in a mesoscopic superconducting structure. Rather, Smith discloses superconducting quantum interference devices (SQUID's) connected in parallel with and distributed along the length of [a] transmission line that have improved performance in the microwave and millimeter wave frequency ranges. The phase shift recited by Smith is the phase of an oscillatory microwave signal propagating down the transmission line. As such, a person having ordinary skill in the art would not view Smith as analogous art as de Bruyn Ouboter and Makhlin.

Second, even if Smith could be properly combined with de Bruyn Ouboter and Makhlin, which it cannot, the combination of references still does not teach or suggest all the elements of rejected claims 3-5, and 41. Claims 3-5, and 41 ultimately depend from either claim 1 or claim 39. As discussed in response to the 35 U.S.C. § 103(a) rejection of claims 1 and 39, above, the combination of de Bruyn Ouboter in view of Makhlin fails to teach or suggest each of the elements of claims 1 and 39, as amended. Smith does not remedy the deficiencies in the combination of de Bruyn Ouboter and Makhlin because Smith does not teach or suggest a phase shifter that interrupts a superconducting loop at a point outside of a multi-terminal Josephson junction (claim 1) or at a point in a superconducting loop other than the coupling of two terminals (claim 39) as respectively indicated in amended claims 1 and 39. As such, claims 1 and 39 are fully patentable over any combination of de Bruyn Ouboter, Makhlin and Smith. Claims 3-5, and 39 ultimately depend from either claim 1 or 39 and therefore

respectively inherit the claim limitations of these base claims. Therefore, claims 3-5 and 39 are fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Smith for at least the same reasons that claims 1 and 39 are patentable over any combination of these references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 3-5, and 41 be withdrawn.

Claims 6, 26, 31, and 40. The Examiner has rejected claims 6, 26, 31, and 40 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Ivanov. Applicants traverse the rejection.

The combination of de Bruyn Ouboter, Makhlin, and Ivanov does not teach or suggest all the elements of rejected claims 6, 26, 31, and 40. Claims 6, 26, 31, and 40 ultimately depend from either claim 1 or 39. As discussed in response to the 35 U.S.C. § 103(a) rejection of claims 1 and 39, the combination of de Bruyn Ouboter in view of Makhlin fails to teach or suggest each of the elements of claims 1 and 39, as amended. Ivanov does not remedy the deficiencies in the combination of de Bruyn Ouboter and Makhlin because Ivanov does not teach or suggest a phase shifter that interrupts a superconducting loop at a point outside of a multi-terminal junction (claim 1) or the coupling of two of a plurality of terminals (claim 39) as indicated by amended claims 1 and 39. As such, claims 1 and 39 are fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Ivanov. Claims 6, 26, 31, and 40 ultimately depend from either claims 1 or 39 and therefore inherit all the claim limitations of either claim 1 or 39. Therefore, claims 6, 26, 31, and 40 are fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Ivanov for at least the same reasons that claims 1 and 39 are patentable over such a combination of references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 6, 26, 31, and 40 be withdrawn.

Claims 14-19, and 45. The Examiner has rejected claims 14-19, and 45 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Ryazanov. Applicants traverse the rejection.

The combination of de Bruyn Ouboter, Makhlin, and Ryazanov does not teach or suggest all the elements of rejected claims 14-19, and 45. Claims 14-19, and 45 ultimately depend from either claim 1 or claim 39. As discussed in response to the 35 U.S.C. § 103(a) rejection of claims 1 and 39, the combination of de Bruyn Ouboter in view of Makhlin fails to teach or suggest each of these claims, as amended. Ryazanov does not remedy the deficiencies in the combination of de Bruyn Ouboter and Makhlin because Ryazanov does not teach or suggest a phase shifter that interrupts a superconducting loop at a point outside of a multi-terminal Josephson junction (as recited in amended claim 1) or a phase shifter that interrupts a superconducting loop at a point in the superconducting loop other than the coupling of two of a plurality of terminals (as recited in amended claim 39). As such, claims 1 and 39 are fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Ryazanov. Claims 14-19 and 45 ultimately depend from claims 1 and 39 and therefore inherit all the claim limitations of either claim 1 or claim 39. Therefore, claims 14-19 and 45 are fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Ryazanov for at least the same reasons that claim 1 and claim 39 are patentable over this combination of references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 14-19, and 45 be withdrawn.

Claims 46 and 47. The Examiner has rejected claims 46 and 47 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Han. Applicants respectfully traverse the rejection for the reasons discussed below.

Applicants have amended claim 46 to recite that at least one of the plurality of qubits in the qubit array has a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. As such, for the same reasons discussed above in conjunction with the 35 U.S.C. § 103(a) claim rejection of claims 1 and 39, the combination of Makhlin and de Bruyn Ouboter fails to teach or suggest all of the claim limitations of claim 46. Furthermore, Han does not remedy the deficiencies in the combination of de Bruyn Ouboter and Makhlin because Han does not teach or suggest a phase shifter that interrupts a superconducting loop at a point

outside of a multi-terminal Josephson junction. As such, claim 46 is fully patentable over any combination of de Bruyn Ouboter, Makhlin and Han. Claim 47 depends from claim 46 and therefore inherits all the claim limitations of claim 46. Therefore, claim 47 is fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Han for at least the same reasons that claim 46 is patentable over this combination of references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 46 and 47 be withdrawn.

Claims 48-51 and 59-64. The Examiner has rejected claims 48-51 and 59-64 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and further in view of Han and further in view of either Smith (claims 48-50), Ivanov (claim 51) or Ryazanov (claims 59-64). Applicants traverse the rejection.

The stated combination of references does not teach or suggest all the elements of rejected claims 48-51 and 59-64 because these claims ultimately depend from claim 46. As discussed, in response to the 35 U.S.C. § 103(a) rejection of claim 46, the combination of de Bruyn Ouboter, Makhlin, and Han fails to teach or suggest a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. As further discussed in conjunction with responses to other 35 U.S.C. § 103(a) claim rejections above, Smith, Ivanov and Ryazanov, either alone or in combination, do not teach or suggest a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. Thus, no combination of de Bruyn Ouboter, Makhlin, Han, Smith, Ivanov, and Ryazanov teaches or suggests all of the limitations of claim 46. Since claims 48-51 and 59-64 ultimately depend from claim 46, these claims are patentable over any combination of the cited references for at least the same reasons that claim 46 is patentable over the cited references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 48-51 and 59-64 be withdrawn.

Claims 80-83 and 86. The Examiner has rejected claims 80-81 under 35 U.S.C. § 103(a) as being unpatentable over de Bruyn Ouboter in view of Makhlin and

further in view of Blais. The Examiner has rejected claims 82, 83, and 86 in view of this combination of references and further in view of Smith, Ivanov, and Ryazanov, respectively. Applicants traverse the rejection.

Applicants have amended claim 80 to recite that each qubit in the plurality of qubits has a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. As such, for the same reasons discussed above in conjunction with the 35 U.S.C. § 103(a) claim rejection of claims 1 and 39, the combination of Makhlin and de Bruyn Ouboter fails to teach or suggest all of the claim limitations of claim 80. Furthermore, Blais does not remedy the deficiencies in the combination of de Bruyn Ouboter and Makhlin because Blais does not teach or suggest a phase shifter that interrupts a superconducting loop at a point outside of a multi-terminal Josephson junction. As such, claim 80 is fully patentable over any combination of de Bruyn Ouboter, Makhlin and Blais. Claim 81 depends from claim 46 and therefore inherits all the claim limitations of claim 81. Therefore, claim 81 is fully patentable over any combination of de Bruyn Ouboter, Makhlin, and Blais for at least the same reasons that claim 80 is patentable over this combination of references.

Moreover, the stated combination of references (de Bruyn Ouboter, Makhlin, and Blais) does not teach or suggest all the elements of rejected claims 82, 83, and 86 because these claims ultimately depend from claim 80. As discussed, in response to the 35 U.S.C. § 103(a) rejection of claim 80, the combination of de Bruyn Ouboter, Makhlin, and Blais fails to teach or suggest a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. As further discussed in conjunction with responses to other 35 U.S.C. § 103(a) claim rejections above, Smith, Ivanov and Ryazanov, either alone or in combination, do not teach or suggest a superconducting loop wherein a portion of a phase shift is provided by a phase shifter that interrupts the superconducting loop at a point outside of a multi-terminal Josephson junction. Thus, no combination of de Bruyn Ouboter, Makhlin, Blais, Smith, Ivanov, and Ryazanov teaches or suggests all of the limitations of claim 80. Since claims 82, 83, and 86 ultimately depend from claim 80, these claims are patentable over any combination of the cited references for at least the same reasons that claim 80 is patentable over the cited references.

For the above-identified reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 80-83 and 86 be withdrawn.

THE CLAIM OBJECTIONS SHOULD BE WITHDRAWN

The Examiner has objected to claims objected to claims 7-12, 20, 22-25, 27-28, 30, 32, 34-36, 38, 43-44, 52-58, 65-79, 84-85, and 87-93 as being dependent upon base claims that have been rejected. In view of the arguments and claim amendments submitted above for each of the rejected base claims upon which these objected claims depend, Applicants believe that these objected claims are fully patentable. Therefore, Applicants request that the claim objections be withdrawn.

CONCLUSION

Applicants respectfully request entry of the foregoing amendments and remarks into the file of the above-identified application. If, in the opinion of the Examiner, an additional telephone conference would expedite the prosecution of the subject application, the Examiner is encouraged to call the undersigned at (415) 875-5744.

No fee is believed owed in connection with filing of this amendment and response. However, should the Commissioner determine otherwise, the Commissioner is authorized to charge any underpayment or credit any overpayment to Jones Day Deposit Account No. 16-1150, Jones Day (CAM No.: 706700-999111) for the appropriate amount. A copy of this sheet is attached.

Date: September 3, 2004

Respectfully submitted,

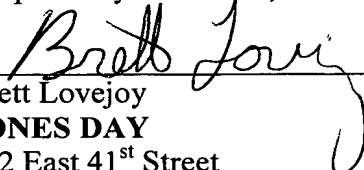

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Exhibit A
PROPOSED FORMAL DRAWINGS FOR FIGURES 14–17

Amendments to the Drawings:

The attached sheets of drawings include newly proposed Figs. 14–17. These sheets, which include newly proposed Figs. 14-17, replace figures that have been cancelled out of the specification by way of amendments to the specification above.